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ABSTRACT

Multidimensional knowledge structures, described from a constructivist perspective and aligned with the "Mind as Rhizome" metaphor, provide support for constructivist learning strategies. This qualitative study was conducted to seek empirical support for a description of multidimensional knowledge structures, focusing on the idiosyncratic nature of knowledge that arose in the classroom and was based upon children's individual prior experience and knowledge. Participants (n=25) were students in a first and sixth grade parochial classroom in a small Midwestern city. Data were gathered through observation and student interviews. Cues and trajectories in the children's representations of knowledge were identified. Implications of the structures for generating and developing multiple perspectives and developing learner ownership are discussed. (Contains 35 references.) (MES)

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MULTIDIMENSIONAL KNOWLEDGE STRUCTURES

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ED 436 142

Abstract

Multidimensional knowledge structures, described from a constructivist perspective and aligned with the Mind as Rhizome metaphor, provide support for constructivist learning strategies. In this qualitative study, cues and trajectories in the children's re-presentations of knowledge were identified. Implications of these structures for generating and developing multiple perspectives and developing learner ownership are discussed.

Background

Hypothetical knowledge structures have been proposed and are used to discuss and describe mental processes from a cognitive theoretical perspective. Schemata (Rumelhart & Ortony, 1977), frames (Minsky, 1974/1997), semantic networks (Woods, 1975), and scripts (Schank, 1975) provide a framework for describing how knowledge is organized in memory, allowing for easy retrieval of information and playing a role in perception and comprehension. Schema, as an example these knowledge structures, are described as existing for generalized concepts (Rumelhart & Ortony, 1977). Yet, when these structures are studied, they are often isolated within a domain of interest for the researcher, and, in fact, are described as being domain organized (Bruning, Schraw, & Ronning, 1995). For example, schema are described for social studies (Duis, 1996; Torney-Purta, 1991) and mathematics (Jitendra & Hoff, 1996; Zeman, 1991). The role of gender schema has been considered in reading and story memory (Day, 1994; Welch-Ross & Schmidt, 1996).

Although a domain focus provides for description of knowledge and knowledge construction processes within particular domains, knowledge and learning that aligns with the constructivist perspective requires a broader look at knowledge structures. Although constructing relationships related to domain knowledge is an important activity in the learning process, just as important is the learner's prior knowledge not related to that domain, which is somehow activated by information in that domain. New information is interpreted by an individual in terms of existing knowledge that is divergent and unique to that individual. This pilot study of elementary students begins to look at how knowledge structures extend beyond the domain, thus providing for the multidimensionality of knowledge structures.

Theoretical Perspective

The traditional cognitivist perspective, as was initially aligned with the information-processing view, tends to view knowledge construction as a process whereby learners develop representations of an ontologically objective reality (Lakoff, 1987). An orientation to teaching that would align with this perspective is a knowledge or information transmission model (Kember & Gow, 1994). Critical in the learning process is the way in which the information is organized, allowing for easy acquisition and retrieval. In the instructional process, the information is often presented in final form (e.g., in Ausubel's (1961) meaningful reception learning), and the learner is to internalize this information (Driscoll, 1994). Although a learner's prior knowledge and experience provide ways for an individual to link to the new information, the instructional process proceeds from the instructor's point of view (Wagner & McCombs, 1995).

From the constructivist view, not only is knowledge constructed, as could also be described from the cognitivist perspective, but a learner has no alternative but to construct knowledge based upon his or her own experience (von Glaserfeld, 1995). The constructivist perspective is based on a subjectivist or interpretivist view of the world. Although a real world is posited to exist, what an individual knows of that world is based upon his or her own experiences and interpretations of that world. Two primary constructivist views currently exist: cognitive-constructivist where learning is a process of active cognitive reorganization and socio-constructivist where learning is acculturation into an established community of practice (Cobb, 1994; Duffy & Cunningham, 1996). The current study focused on knowledge structures of individual students, and is more appropriately aligned with the cognitive-constructivist view. From this view, learners are to reshape or transform information, resulting in new cognitive structures (Brooks & Brooks, 1993). Theses structures, rather than being prescribed and defined by a teacher, are idiosyncratic to learners based upon their own experience and prior knowledge.

In constructivist learning, the instructor acts as a facilitator or coach, supporting students in the learning process by providing resources and modeling thinking skills. More critically in this bi-directional process, the instructor should come to understand the learner's point of view, then pushing the learner to the edge of his or her thinking to foster a perturbation that will extend the learner to expanded understandings (Duffy & Cunningham, 1996). Principles of constructivist learning environments include that of learner ownership where problems have

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relevance to the students, generation and evaluation of multiple perspectives, and problem and environment complexity appropriate for the learner and faithful to the task (Duffy & Cunningham, 1996; Honebein, Duffy, & Fishman, 1993; Savery & Duffy, 1996).

These characteristics provide a rationale for broadening the view of knowledge structures, not only beyond domains, but also to capture the idiosyncratic experiences and knowledge of learners. Knowledge is often described as being idiosyncratic (Alexander, Schallert, & Hare, 1991) thus, there needs to be an opportunity for learners to create, consider, and express their own unique knowledge as well as descriptions of knowledge structures that capture the idiosyncratic nature of knowledge.

Accessing Knowledge Structures

Typically, concept maps (Beyerbach, 1988; Shavelson & Stanton, 1975) and semantic ordered trees (Strahan, 1989) have been used as methods for gathering information about knowledge structures. There are variety of ways in which these have been implemented. For example, when using structured concept maps, concepts are provided and the learner is asked to identify the links among the concepts. In unstructured maps, the learner is provided the topic area rather than individual concepts. This method can provide for idiosyncratic views among individuals (Winitzky, Kauchak, & Kelly, 1994). However, even within the unstructured maps there may be implied constraints to remain within the topic or domain and not identify meaningful connections beyond. In fact, few studies have avoided limiting a learners knowledge structures to predefined concepts (Lederman, Gess-Newsome, & Latz, 1994). Ginsburg (1997) challenges that if one is to consider knowledge from a constructivist perspective, one has no alternative but to consider more non-standardized forms of data collection, ones that allow for the point of view of the learner.

Alternative Perspective

The Mind as Rhizome metaphor provides an alternative perspective from which to view knowledge. A biological example of a rhizome is a root crop such as tulips or crab grass, a system of stems, roots, fibers with fruits of tubers, bulbs, and leaves (Duffy & Cunningham, 1996). When applied as a metaphor of mind, the rhizome provides a number of characteristics that aid understanding of mind from a constructivist perspective and captures the idiosyncratic nature of knowledge as well. A rhizome continuously grows in dimension, changing its own nature as it increases in dimension. Thus, the rhizome is a dynamic system, one that changes through time. Features within the rhizome are heterogeneous, not needing to be similar to one another, each point having the potential to be connected to any other point. This potential connectedness has no hierarchy or genealogy, there being no subordinate points within the structure. A rhizome has an infinite number of entrances, or points from which it is viewed, yet it has not outside. Without an outside, it can only be described from the inside, from one of the infinite vantage points within. It is an open network in a which everything could be connected to everything else within a multidimensional space (Deleuze & Guattari, 1983; Duffy & Cunningham, 1996). Because of the potential for infinite connections and its dynamic existence, each view or perspective from within must be idiosyncratic.

Traversing the rhizome, moving through the maze-like structure, is described as a map (Deleuze & Guattari, 1983), although a path may provide a better way to conceptual this process. A path through the rhizome (a trajectory through the dynamic system) is not static, but a continuous construction capturing knowledge as a process. In contrast, if one considers that a concept map could capture a portion of the rhizome, knowledge appears a static commodity. A concept map seems to sever the connections that exist between the concept map and the rhizome from which it was removed. Thus, knowledge's idiosyncratic nature is suppressed. Knowledge, when considered as a dynamic path or trajectory through the rhizome, is affected not only by new information it encounters, but the entire path from which it emerged. The multidimensional rhizome of infinite connections captures a mind that includes past experience and knowledge as a basis for a continuing construction process as new information and experience are encountered.

When considering the multidimensionality of the rhizome, it is not difficult to speculate what the dimensions of multidimensional knowledge could be. At a minimum, time is an added dimension. Alexander and Murphy's (1998) description of an individuals knowledge base, based on learner-centered psychological principles aligned with the constructivist perspective, included sociocultural, strategic abilities, personal beliefs, and goals as interactive dimensions. Ginsburg (1997) stated that "cognition without emotion is vacuous" (p. 65), adding another dimension. These, and likely many others, provide a trajectory or path, reflecting the many types of connections an individual can construct at any given time, based on personal experience and knowledge. Any one of these dimensions may be encountered and followed at any time during learning. When studying knowledge structures, all types of trajectories should be considered relevant. Domain or subject areas, along with these other dimensions, do provide potential for infinite connections with unique past experience and knowledge of learners. The rhizome metaphor with its heterogeneous infinite connections, coupled with data gathered through non-traditional methods as suggested by Ginsburg, provides a framework for study of a more divergent look at knowledge.

Purpose and Guiding Question for Study

The purpose of this study was to begin description of hypothetical knowledge structures based on empirical data gathered in learning situations. The rhizome metaphor provided a framework from which characteristics of broader knowledge structures could be described. The study sought a description of knowledge structures that (a) were distributed, allowing for heterogeneous, multiple connections that existed within one's knowledge, and (b) contained connections that extended beyond domain-specific boundaries thus adding dimensions. The broad guiding question for this study was: How can knowledge of these elementary school children who were situated in an existing school environment be described as multidimensional knowledge structures?

Methodology

A qualitative study was conducted seeking empirical support for a description of multidimensional knowledge structures, focusing on the idiosyncratic nature of knowledge that arose in the classroom and was based upon children's individual prior experience and knowledge.

Participants

Participants for this study were a first and a sixth grade parochial classroom in a small Midwestern city. The first grade class had 14 boys and 11 girls, ages 6 to 7, of which 13 consented to participate in the study (8 boys and 5 girls). The sixth grade class had 9 boys and 15 girls, ages 12 and 13, with 3 boys and 9 girls participating in the study. Prior to the beginning of data collection, the researcher visited the classrooms, was introduced to the students, and, in the first grade class, interacted with the children by assisting them with their class work. The first grade teacher stated that these early encounters with the children identified the researcher as a helper and increased the children's comfort level and willingness to talk in the interviews. The sixth grade teacher was used as a secondary participant.

Procedure

Data was gathered through a variety of sources using a number of methods as appropriate for a qualitative study (Lincoln & Guba, 1985). Each classroom was observed three times, the first grade during a variety of subjects and the sixth grade during social studies. In the initial design for the study, instances of idiosyncratic comments and questions by students were sought. Students were to be interviewed about the source of these idiosyncratic comments and questions, seeking connections between them and the new information. After the first observation in each class it became clear that these instances would not occur in any abundance, perhaps resulting from the didactic nature of the classrooms. The design evolved so that interview students were randomly chosen. Nine first grade students and three sixth grade students were interviewed. The individual interviews were conducted after the classroom observation, were audio taped, and later transcribed.

Each semi-structured interview began by having the child describe what he or she remembered from the class session. Open-ended questions followed, asking the child about idiosyncratic comments that he or she may have brought up during class (e.g., During your lesson today you brought up _____. What made you think of that?) or may have had covertly (e.g., At times, when we're learning one thing, other things pop into our head that are not what about we're learning. Sometimes we hear the teacher say might remind us of something else we know. While you were studying ____ this morning, did anything like that pop into your head?). The interview followed from the child's comments, each interview lasting less than 15 minutes.

The sixth grade students also completed a brief writing activity on the Vikings, their topic that day in social studies. A 15 minute introduction to the writing task allowed the students to ask questions about what they were to do and helped ensure their understanding. Students were provided open-ended prompting questions to help them begin the activity (e.g., Describe the conquests of the Vikings.) and were told that if something popped into their heads, regardless of its relationship to social studies, to follow that thought and write about the new topic. Students were asked to include why the new topic was related and were provided a number of example transition sentences to aid this process (e.g., This reminds me of ____ because _____.). Writing time was extended from the 30 minutes initially planned to 45 minutes as the students continued working on the activity. Students were able to use their textbooks for the writing activity to help them with ideas and spelling and were asked to indicate if they used their book none, some, or a lot.

The sixth grade teacher was interviewed following student data collection. This interview was a means to further triangulate the data and gain further understanding if some of the links that the students provided in their writing and interviews had occurred previously in classroom instruction or in school. In this, the role of the teacher was not to confirm or deny the students' knowledge construction, but to provide information about the basis of some of the connections.

Analysis

Analysis proceeded as typically done in a qualitative study, seeking trends among the data from the various sources (Bogdan & Biklen, 1982; Lincoln & Guba, 1985). Data from the observations, interviews, and writing activities were reduced to series of propositions (Novak & Musonda, 1991), generally single sentences or topic areas. These were then reviewed for points or ideas from which one topic or idea moved to the next.

Results

Heterogeneous, Multiple Connections: Cues

Two primary trends emerged through the analysis. First, within the children's writing and interview data there existed cues, stimuli that allowed the child to turn a mental or verbal corner, digress from the topic at hand and follow a path to a related concept or idea. Although these cues seemed similar to the cues described from the cognitive learning perspective used to aid information storage and retrieved (Bruning et al., 1995) they were not teacher defined or mediated (i.e., a part of the pre-planned structure of the topic to be learned). These cues occurred either in the learning environment, generally from a teachers comment or question, or from a child's own thoughts (verbally or in writing) as a type of re-presentation (in the Piagetian sense) where individuals replay or reconstruct their knowledge to themselves (von Glaserfeld, 1995). For this study, cues often appeared as single words or concepts, making it clear where the learner turned a cognitive corner or chose a path in the rhizome that was different from what the teacher was presenting or what the learner was currently writing. Analysis identified the following cues: sounds like (two words that sounded alike but shared no meaning), looks like (a visual cue that looked like something else), same word but different concept (a word or derivation of a word that described two different ideas), same concept but different context (an idea or concept that occurred or existed in other circumstances), series (an itemized set of words), and complex relationships (an inference is an example).

An observation of Tim's[1] first grade reading group provides an example of a same word but different concept cue. Tim has a different conception of the word "meadow" when it is presented as a new word.

> The teacher, introducing the story The Frog and the Toad, asked the small first grade reading group what a meadow was. Meadow was a new word in the story.
>
> "A meadow is a place with a few buildings," Tim said.
>
> The teacher paused, "Meadow Wood, where your grandpa lives," she interpreted his response.
>
> "Animals live in a meadow," another student offered.
>
> "There's a fountain in a meadow," Tim said.
>
> The teacher tried to clarify, "They call it Meadow Wood because it looks like a meadow."
>
> The students offered other descriptors of meadow. "A meadow is flat." "A meadow has flowers." "A meadow has deer." "A meadow has raccoons."
>
> The teacher added, "A meadow has possum." Still addressing Tim's idea about meadows, she said, "In Meadow Wood sometimes animals come near the buildings and eat the plants. A meadow is a flat, grassy place." (observation, grade 1, April 6, 1998)

It is clear that Tim's definition of the word meadow, although the same word, does not match that of the teacher's. Although Tim's idiosyncratic definition of the word is incorrect based on the teacher's definition, it *is* a definition consistent with his prior experience and knowledge. As the teacher tries to clarify this, it becomes clearer that although the same word, Tim has a different concept in mind.

The interviews and writings of the sixth grade students provided examples of more sophisticated cues. Beth brings up a question in her interview that she wondered about during class, "If we had a test question on what happened on Christmas day in the 800s would it be both answers?" (Beth, age 12, April 13, 1998). Her question occurred in a lesson on Charlemagne where the students were told the Charlemagne had been crowned Holy Roman Emperor on Christmas day. Broader than being the same word, as was Tim's case, Christmas is a concept, or idea. Beth had the same concept of Christmas as the teacher. Her question indicated that this concept can extend beyond contexts (that of learning a particular event in social studies in the classroom and that the traditional view of Christmas).

In the same sixth grade lesson, Anne's interview provided another concept that was touched on in class that she moved into different contexts.

> I asked Anne, "When you're sitting in class, or when you're sitting anywhere, but we'll kind of focus on social studies today (yeah) and you're hearing things, like Mrs. Larson is asking questions, and you're discussing the topic, or you're looking at the book or whatever, a lot of times other things will pop into our minds (uh huh) so I was wondering if during social studies anything popped into your mind."
>
> "Well, I have a track meet this afternoon so I was thinking about if it was going to be rained out or not. ("OK," I interjected.) and I was thinking about how I went to the art museum in Chicago when she mentioned art." (Anne, age 12, April 13, 1998)

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1 Student and teacher names are pseudonyms.

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The teacher had mentioned that art was encouraged in the schools during Charlemagne's time and that churches were like museums because of the artwork in them. Since the mention of art in the class was at the end of the lesson, perhaps Anne's recall could be attributed to a recency effect. But, later in the interview, when prompted about the most interesting thing about the class, she returned to the topic of art showing that she had considered the concept a bit beyond the mention in class, making a comparison to art work in the churches now, although not expanding any further.

> "I thought the art work in the church was because usually these days all you see is stained glass and everything (OK) and you don't really see anything except like the stations, but you never really see any art work."
> "OK, why do you suppose that is?"
> "I don't know." (Anne, age 12, April 13, 1998)

Anne mentioned twice in the interview that social studies was boring. When called on to answer a question during class, Anne had to ask the teacher to repeat the question, then thumbed through her book, and eventually provided an answer. Another sixth grade student, who said that history was her favorite subject, identified a different concept that she extended beyond the current context in her re-presentations. Wendy focused on the wars that Charlemagne had fought, being able to identify his foes.

> Well, in history I was thinking, because I really looked over the chapter really good. I was really thinking more about all the wars we've been through with other countries, Vietnam War and World War I and World War II, and I started thinking about the Titanic ship, because I read a lot on that, and how there were three boats named Titanic and they all sank. So, I was thinking if that was a curse name or something. And then she started talking about how they switched the Franks and stuff and I thought about that in history, and I eventually when back to thinking about other stuff. (Wendy, age 12, April 13, 1998)

When asked later in the interview to talk more about the idea of wars that were triggered, asking if she saw relationships between the two, Wendy continued following a path among her areas of interest. The concept of wars is extended to fighting and the use of peace treaties, again returning to a war that she had mentioned earlier.

> Yeah, I think we still fight, except we fight a lot more about stupider things, like religion, I know it's important but it's not something we should really fight over, we should just get along and try to like divide it. I watch a lot of videos because my mom works for National Geographic company and if she sells so many products she gets a video. So I sit down and watch it. Like the Titanic one. That was a little boring because it was mostly stuff I knew. But when it was about Egypt and stuff and talked about the mummies I thought that was cool. I think they considered things more about violence because you're basically surrounded by it. Basically, like guns and all that, like kids killing other kids and the wars going on around us. I know they're trying to have a peace treaty with, I forget with what country, and I don't think peace treaties work because they break them like when Hitler broke the one in WW II. They usually keep them for a couple of years, or a decade or so and then they'll break them which is not very good. I think if you make a promise you should live up to your promise unless something really big comes along. (Wendy, age 12, April 13, 1998)

Wendy later continued by talking about freedom, linking the idea of being forced to change religion (as was done with Charlemagne's conquests) and the idea of being able to choose things for herself, such as books to read. Although the tangents of discussing Egypt and the Titanic in the interview seem irrelevant, two weeks later during the sixth grade writing activity on the Vikings (where Wendy stated that she used the book some) she returns to the same topics.

> I like the Vikings tons but who could beat the Romans. Talk about cool. They rule everything. They had everything right till their good ruler died then they had their downfall. Egypt was cool too. I liked how they wrapped their dead up. My great uncle just died it was sad. I can't turn my book to the Egypt pgs at school because on 3 pages it [was] all muddy. I did not mean to do it. I left my book open and my dog jump with his muddy paws all over it. I'm planning to tell Mrs. Larson the last day of school and I will bring $5 to pay for it. I just don't want to be yelled at. I hate that. Egypt is hot but they have nice piramids and status [statues]. The Egypt people had grave takers. That would be mean to take some ones thing and not let them have their peace. I know I would hate it if anyone took anything special to me like my bennie babies, titanic stuff, or radio. (Wendy, age 12, April 27, 1998)

The linear format of writing allows only one cue to be followed at a time. But, Wendy's return to the topic at hand, as well as her returning to a topic two weeks later, is a way that multiple connections to the same concept can be captured.

These few examples of cues, of which 76 were identified in the data, indicate how simple a cue can be. Yet, a cue has the potential for multiple heterogeneous connections stemming from it. For example, the concept of "art" in Anne's thoughts did not have only one connection, but many. Further, the types of connections, the context where they initially developed, were different. Beth was building a number of connections stemming from the Christmas cue. Wendy had a number of connections with the concept of war. That these cues are not singular concepts, although reported as such, suggests distributedness. Anne's knowledge about art is not a self-contained singular

concept described in a hierarchical structure. Neither is Wendy's knowledge about war. When comparing Wendy's interview and writing, we see that some concepts reoccur (e.g., Egypt), yet the context and description of them has changed, based upon the current reporting and situation. While Tim seemed to have only one connection to the word meadow, we can speculate that perhaps after the class he had another. Tim's meadow cue, whether described as correct or incorrect, as well as the other cues identified that might have been categorized as being off-track, reach beyond the topic at hand, perhaps even beyond the domain. The cues provide the prompt to move beyond a topic and connect the information in an idiosyncratic way, a corner to a different dimension in ones knowledge.

Beyond Domains: Trajectories and Dimensions

Once a cue was encountered, the learner followed a path, or trajectory, through the current slice of the rhizome. If a cue is a cognitive corner, the trajectory is the street that the learner is on once the corner is turned. Rather than describing the trajectory by the actual script of experiences and thoughts, a trajectory may be better described by the nature of the path, or the dimension at which the learner arrived. The nature of this path could be characterized in a number of ways, based on the type of experience and who the players in the experience were. Trajectories identified in the data were: experience (activity), personal (thoughts and ideas), family, friends, school, society, emotion/affect, and abstract ideas.

Following the observation of the first grade reading group, Tim was interviewed. He confirmed the observation made by the teacher, Tim derived his meaning of the word meadow from personal experience based on where his grandfather lived.

> Tim gave me a summary of The Frog and the Toad, the story his reading group had discussed, which had contained a new reading word: meadow. I asked "I remember you were talking about your grandpa. What made you think about that?"
>
> "I don't know. When she said 'meadow' I thought of that one."
>
> "Yeah, because he lives in place that's called Meadow," I paused, not remembering.
>
> "Wood," he quietly interjected.
>
> "What was it called, Meadow Wood?"
>
> "For old people that have strokes," he continued. "He had a stroke and he's paralyzed and, um, we just go there to visit him."
>
> "Oh, sounds like a nice place for him."
>
> "Yeah, it has a water fountain, there's a dining place where he used to be able to go out and get food there, when my great-grandma was alive, but she died. And he can't go there any more because his foot's too swollen."
>
> "Oh."
>
> "There's lots of neat things there."
>
> "Yeah. They called it Meadow Woods and your teacher said that's maybe because it used to be a meadow, right."
>
> "Used to be a meadow," he, again very quietly, said.
>
> "So what's a meadow like?" I asked.
>
> "I don't know. It's pretty calm, quiet." (Tim, age 6, April 6, 1998)

Although it is not clear if Tim ever developed the teachers definition for the word meadow, it seems clear that Tim's conception of meadow, and the context from which it emerged was a particularly meaningful connection of Tim's. The meadow cue lead to a rich description characterized by a number of dimensions. Tim's trajectory, the nature of the path that the cue "meadow" lead him, could be characterized as an experience because he had experienced Meadow Wood first hand and visited his grandfather, and also has a family dimension. Although Tim doesn't express emotion overtly about this grandfather, his way of communicating and his mentioning sickness and death, provided an emotion/affect dimension. Tim's trajectory extended beyond the domain area of reading, the story of The Frog and the Toad, and the new word "meadow."

Anne's trajectory on art could be classified in multiple ways as well. It followed from an experience, but also included society (art in churches) and also school given that she attends a parochial school. Beth's Christmas cue likewise had both society and school connections. Although she didn't specify, we can also speculate that there would also be experience and family connections.

Wendy's re-presentations provide an example of ties both within and beyond a domain. The nature of the paths largely focused on society and school (although the wars she mentioned had not been studied in the current school term) as well as personal (without an identified experience). Wendy's ability to synthesize ideas is instructionally encouraging, indicating a number of possibilities for considering knowledge in a multidimensional way, synthesizing within the domain, as well as reaching outside of it to broader societal issues. Although history was Wendy's favorite subject, she struggles with it and her other school subjects when it comes to assessment. Her interest and synthesis abilities do not seem to emerge in the classroom.

Cues are easy to identify, often being of singular type and usually simple (such as a single word). Trajectories are more difficult to capture, given the number of ways the nature of the path could be described. While it seems redundant to classify a trajectory as both experience and family for example, the further classification

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provides a more accurate description of the context that surrounds the trajectory. When considering another context, notions like Tim's view of meadow can no longer be incorrect, only idiosyncratic.

When considering cues and trajectories in relation to the rhizome metaphor, they begin to provide a description of a slice of the rhizome, a local description from the view of the individual. A cue is that point from which there can be an infinite number of connections. At that point, the trajectory that will be followed is not only based upon that cue, but the infinite number of connections that exist with that cue. The path a learner follows at the moment relies on past experience and knowledge that have been parts of previous trajectories, each leaving "cue residue" that can be connected at any time should the context and new information be remotely appropriate. These cues are not teacher defined. Only the meadow cue reported here might be considered an intentional cue, the teacher trying to build cues by building vocabulary. Both classrooms were didactic in nature and the teachers were seeking answers that had been defined a priori to their questions. The trajectories of the students were not a part of the intended path that the teacher would have set through the rhizome yet provided potential relevant connections for that particular child. This brings up compelling questions about the implications for instruction from a constructivist perspective, a view that should find value in the nature of these self-identified cues and idiosyncratic trajectories.

Implications for Instruction

Within the constructivist perspective a number of instructional strategies have been discussed, including problem based learning (Savery & Duffy, 1996), cognitive apprenticeships (Collins, Brown, & Newman, 1989), and anchored instruction ((CTGV), 1990). Principles that these instructional strategies embrace include that of learner ownership, generating and gaining multiple perspectives, providing a range of contexts in which the concept might appear, anchoring to a larger task or problem, and providing for reflection on the process and content (Honebein et al., 1993).

A number of these characteristics provide a framework for the role of cues and trajectories in instruction. Learner ownership, taking responsibility for his or her own learning and performance, is something which cannot be directly handed to a learner (Honebein et al., 1993). In fact, oftentimes, learners will reject the specific learning objective that might be specified by the teacher (Savery & Duffy, 1996). In this study, it is difficult to imagine that Anne, for example, accepted and owned the predefined instructional goal in the study of Charlemagne, considering her boredom with the class and her inattentiveness. However, even for Anne, there was a cue, or hook, that could potentially provide relevance for her learning. Art is a concept that Anne had some interest in and could be used to provide her an opportunity to find relevance in her learning of a boring subject. The didactic nature of the classroom did not allow for this opportunity to occur and, in her summary of the lesson, Anne seems to know little about the topic. A self-defined cue, such as art for Anne or any of the cues that occurred in Wendy's re-presentations, could provide avenues whereby ownership could be developed by learners within the instructional process. Although a teacher cannot know what simple ideas or words might serve as cues for each learner, the facilitator role allows interaction to occur where a student may be willing to express a cue and what trajectories might be followed—providing personal relevance to the topic. The teacher can then guide the learner to purposefully choose a trajectory that is relevant for the learner as well as appropriate within the curriculum.

We could consider that Tim actually clung to the notion of learner ownership as he kept trying to use his meadow as the meadow the teacher was talking about, offering his characteristics of meadow from his perspective. His personal definition, although seemingly incorrect, provided an opportunity for him to add personal relevance to his learning. Further, Tim provided a perspective different than the teachers, his own. Generating and gaining multiple perspectives can only come after a child has developed his or her own perspective. Further, learners' perspectives must be considered to be viable. What is the chance of generating multiple perspectives if a perspective is immediately labeled by another as not viable?

Anne, Wendy, and Beth's interviews were all held after the same class lesson on Charlemagne. Yet, each of them had different self-selected cues that provided them an opportunity to extend beyond the class topic and the explicit information presented. As each child provided a brief synopsis in her interview of what had been covered in class, each remembered different aspects, personally relevant because of her own experiences, knowledge, concerns, and interests. Not surprisingly, Beth's synopsis contained a statement about Charlemagne being crowned Holy Roman Emperor, Wendy's included a listing of his wars and who he fought, and Anne mentioned the artwork in the church. Each could develop a different perspective on the topic if provided the opportunity. Sharing these perspectives could lead to gaining multiple perspectives. But, for that to occur, each child would need the opportunity to further expand their personal view of the topic into a perspective.

A methodological question arises when one considers that the re-presentations described in the interview did not actually occur previously in the classroom as reported. Certainly, it is possible that the students (other than Tim) could not have had these re-presentations in class at all. But, perhaps it is not important. The fact that cues and trajectories could exist, whether in the classroom or in a private interview, indicates that the connections between personal experience and knowledge to the new information are easily accomplished. Perhaps learners have been trained to self-regulate their learning too well, not offering personal links. What is needed is support for students to

thoughtfully consider meaningful cues based on personal experience and synthesize the trajectories with the new information. Rather than convergence, divergence and a broader view of knowledge is needed both for teachers and learners.

It seems that learner ownership and generating and gaining multiple perspectives will go hand in hand. It also seems that a likely place for these to develop is by providing students opportunities to self-identify cues and then follow a personal trajectory. Despite a didactic teaching environment, cues did emerge on their own. The fruitfulness of the trajectories that a learner may choose to follow will only become evident if the instructional method provides an opportunity for it to be followed and considered. Given the infinite number of entrances into the rhizome, each one unique to an individual learner, it seems like it might be easier to consider knowledge structures as multidimensional than to constrain them.

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